American Foundryman

A PUBLICATION PRESENTING ASSOCIATION AND CHAPTER ACTIVITIES

Tapping a Cupola. (See page 2) Courtesy Greenlee Bros. & Co., Rockford, Ill.

A Word on Apprentice Training, See Inside Front Cover—Cupola Practice, by D. J. Reese, See Pages 2 to 6—"Home Made" Sand Equipment, See Page 6—Optimum Flow Conditions in the Molten Metal, See Pages 10 to 12.

August
1940

A Word on Apprentice Training

WHEN we review the great strides made in all phases of technical development through the medium of our A.F.A. activites we are apt to overlook the more prosaic branches of our Association. In this latter group is one of our most worth-while activities, Apprentice Training work.

The committee on training of apprentices, according to Association records, is the oldest standing committee of record, and by this token its work has long been recognized as being one of the more important functions of our A.F.A. Consider if you will some of the better known activities of the group.

Everyone is familiar with the apprentice contests held each year in patternmaking, and the three branches of molding where the work of the winners in each instance is on display during convention week. Many chapters are broadening these contests in their own localities and reaping rewards through increased stimulation of interest among the boys.

An outstanding piece of work has been the development of standards for foundry apprentices and the more recently completed standards for patternmaking apprenticeship. Many hours of careful study and painstaking work have gone into the preparation of these standards and your committee believes the benefits to the industry will justify the efforts put forth.

Each year, sometime during convention week, is held the session on apprenticeship training. Many interesting and helpful ideas have been presented and developed through presentation of papers on this subject. Those of you who attended the 1940 session witnessed a striking example of the work on training apprentices. Two of the speakers, young men who are graduates of apprentice training courses in their respective plants, are now in charge of apprentice training in those plants today. They described present day methods of training as compared to courses which they had previously completed. Their talks were most instructive, well presented and well received.

Already foundries are feeling the pinch caused by the lack of trained mechanics and we cannot stress too much the necessity for planned training of skilled men in the foundry. During this time when the resources of the nation are being assembled let us not overlook the value and importance of this great work—Apprentice Training.

C R Culling

C. R. CULLING,
Director A.F.A.

C. R. Culling, vice-president Carondelet Foundry Company, St. Louis, Mo., is a director of the Association, and for several years has served on the Apprentice Training Committee representing the foundry executive group. Mr. Culling has been an active member of the St. Louis district chapter and has been prominent in the work of the Gray Iron Founders' Society, of which he is a past president. He learned the foundry trade as an apprentice of the Carondelet Company. During the World War he served in the U. S. Navy.

American Foundryman

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Cupola Practice

By Donald J. Reese, New York City

Donald J. Reese, metallurgist, International Nickel Co., New York City, is one of the most widely and favorably known authorities on cupola operation, having presented papers on this subject before practically every chapter of the Association and before local foundry groups, as well as having presented technical papers at annual A.F.A. meetings. He was first chairman of the Chicago Chapter, first A.F.A. chapter, and was later first chairman of the Metropolitan New York-New Jersey Chapter. The paper reproduced here was that presented by Mr. Reese before the shop operation course of the 44th annual convention of A.F.A., Chicago, May 7, 1940.

ALTHOUGH we have given numerous talks before foundry groups on the subject of "The Cupola," we do not pose before you today as a "cupola expert" but only as one of you desirous of giving to the other fellow what we have, that may be of value to him, and hoping that our brief association today will be mutually beneficial. We are frank to confess that we are continually learning something we did not know before and occasionally we find it necessary to change a long-held opinion for one that is almost a complete reversal of thought. We are in an era of rapid progress in cast iron metallurgy and a cupola practice that might have been quite satisfactory yesterday may be quite insufficient for the needs of tomorrow.

The Future

And who can tell what tomorrow's needs will be in this industry of ours? In the upset world of today, we may be called upon most any time to do things which we now think are fantastic, but we would remind you that it was just a little more than 20 years ago that we participated in a war and the demands on the foundry then were also fantastic.

The Past

At that time, little was known about the metallurgy of cast iron, little was known about the physical properties, in fact, very little was known about testing cast iron. We went into that war with the tensile strength of cast iron pegged at 20,000 lb. per square in. and upped this property to 35,000 lb. per square in. under the pressure of the times. Only ten years ago we were right at the top when we could attain 40,000 lb. per square in. tensile.

The Present

Today a first-class foundry can produce 60,000 and tomorrow it may be 80,000 or even 100,000 lb. per sq. in. strength iron. In fact, both of the latter figures have already been attained. We do not wish to infer that the tensile strength of cast iron is of paramount importance, but as many other good qualities, as compression strength, impact resistance, modulus of elasticity, etc., improve as tensile strength improves, the term "tensile strength" simply serves as a definite yardstick to evaluate quality.

Nor have we lost sight of the fact that our subject is "Cupola Practice" and not "Cast Iron Metallurgy." We simply use this method of saying that whatever may be the quality demanded the cupola can probably measure up to the job.

Methods of Melting Cast Iron

Your speaker does not infer that other types of melting media are without merit for such is not fact. The common product of the cupola, cast iron, is also produced in electric furnaces, crucibles, air furnaces, open hearth furnaces and various combinations of furnaces.

It is not necessarily true that the large tonnage foundry is a cupola shop for we need only a slight acquaintance with our roll foundries to realize that an important tonnage of cast iron is melted in air furnaces. Some of our large roll foundries make castings that require 200,000 and 300,000 lb. to pour and they handle them with as much facility as most of us would a 5,000 or 10,000 lb. job. Then we might find the small foundry, when suitably located and catering to a specific type of business, using an electric furnace. It too may be perfectly justified in using that particular type of melting media.

From your speaker's experience no one type of melting furnace has proven superior to all others in producing a quality product, for what one producer has accomplished in one type of furnace, another producer has accomplished with equal facility in an entirely different type of furnace.

Some Factors in Cupola Operation

In 1938, your speaker presented a paper* on "Cupola Operation" at the A.F.A. convention, giving his thoughts on sizes and weights of various materials in the cupola charge, relationship of blast pressure and coke bed heights, relationship of coke and iron charges to cupola diameter, fuel ratios, cupola and tuyere design, cupola blowers, air volume or weight control, pressure gauges, etc. In 1931, another paper on "Cupola Practice" gave his thoughts on the different zones in the cupola, functions of the coke bed, functions of slagging, tapping methods, reasons for refractory damage in the melting zone, fuel-metal relationship, metal temperatures, etc. These talks serve as a background for our discussion today.

The Cupola Is Versatile

We think of the cupola as a high speed or large tonnage melting unit, for what other type of furnace can melt 500 tons in one day or deliver 5, 10, 20 or 30 tons per hr. continuously, for as many hours as one requires?

*TRANSACTIONS, *American Foundrymen's Association*, vol. 46, pp. 173-192, 1938.

And because of these two outstanding qualities of "speed" and "tonnage," we are quite likely to overlook the fact that this furnace is also quite "flexible" or "versatile."

Cupola Charges

If you are operating a 72-in. diameter cupola, you are quite likely to be using a 3,000 or 4,000 lb. iron charge, but you could use a 1,000 lb. charge. If you are operating a 36-in. cupola, you are probably using an iron charge weighing in the neighborhood of 1,000 lb., but this size cupola would do a good job with charges of 250 lb.

If you have a special job to make that does not tie in very well with the weights of your cupola charge, you either hold up the production of the job until you have more work of a similar nature or you go ahead with production and dispose of whatever extra metal you have melted in some other job that may be able to take it or you pig the over iron. As a matter of fact, the cupola is probably flexible enough to be adjusted to suit the requirements of the jobs you have to make and the simplest way out is to alter the weights of your cupola charge to suit. In other words, you probably could use a charge weighing only half or even a quarter of your present charge and attain satisfactory cupola performance. Your speaker has operated 72-in. cupolas with 1,000 lb. iron and 120 lb. coke charges, taking off three charges at the beginning of a day's run to meet a high strength iron specification in a foundry ordinarily making a 30,000 lb. tensile strength iron.

Some types of furnaces are given credit for an outstanding ability to salvage the waste materials of industry, such as borings, turnings, etc., but again from your speaker's experience no one type of furnace is superior to all others. One need only look over the yard in any roll foundry to realize that the air furnace contributes its share to the salvage operations of the foundry industry, for what other type of furnace can compete with it in salvaging scrap iron rolls from the steel mills? Even after these rolls are put under the "drop ball" some of the unbreakable chunks may weigh 3 or 4 tons or more.

The problem of salvaging waste materials is less one of a suitable furnace and more one of assurance of the dependability of the composition and condition of the materials to be salvaged. Many manufacturing concerns, particularly in the automotive industry, have pushed salvage operations in their foundries to a high degree. One operator uses as much as 60 per cent briqueted borings in the cupola charge.

Briqueted Borings

There is no reason that we know of that would not permit the use of a charge of 100 per cent of briqueted boring except dependability and working out a practical cycle in the melting department of the foundry. One eastern foundryman uses a cemented briquet made up of 18 lb. of borings and 2 lb. of cement. Ten per cent of the cupola charge are briquets and the product of the foundry is textile machinery. We are not sure that it requires 2 lb. of cement to bind 18 lb. of iron borings nor are we sure that there is sufficient economy involved in this type of briquet to make this salvage operation generally attractive, but the fact that this salvage operation is being successfully carried out in the textile field where casting sections are light and machinability problems likely to be acute is of sufficient interest to warrant mention here.

We recently saw a cupola operation in which the charge consisted almost 100 per cent of coiled wire rope, not halved or quartered but charged into the cupola in full coils weighing about 150 lb. each. During 1939, a reputable mid-western foundryman experimented with charging heavy steel turnings "as is" into the cupola, not briqueted and not pressed into bundles or put in containers. More than 100 tons were used and it is likely that several times this amount will be salvaged during this year.

We regret that we are unable to say when a turning or boring becomes a "heavy steel turning" or a "heavy iron boring" but as data on machine tool operations is in terms of "speeds and feeds," it should not be difficult to determine this point within the next few years. However, we refer to a heavy steel turning only in the sense of its suitability for charging "as is" in the cupola and not in the sense that the machine tool operator would classify it as light or heavy.

Cupola Not Limited to "Average Quality Cast Iron"

It is not uncommon to find that the average person believes the cupola is limited to "just an average quality" of cast iron and it might be of value to point out a few uses of the cupola which might serve to broaden one's thinking in terms of its suitability as a melting medium. One of the first alloy steels developed was Hadfield's manganese steel, frequently referred to now as austenitic-manganese steel, containing 10 to 14 per cent manganese. This steel was made by adding molten ferro-manganese to an ordinary low carbon steel made in the Bessemer converter. The ferro-manganese was melted in a cupola. This method produced a very excellent grade of manganese steel, but the manganese losses encountered in remelting manganese steel scrap in acid lined furnaces made it a more expensive method of production than to do the job in basic lined furnaces, so the usual method of production today is a straight melting in basic lined furnaces. However, those of us metallurgically inclined know that few elements are more difficult to handle in acid lined furnaces than manganese, yet the cupola played a major part in making manganese steel by melting ferro-manganese. On a recent visit to a manganese steel producer's plant, equipped to produce either by melting in a basic lined furnace or in an acid lined furnace and a cupola, we found them preferring the latter method.

Melting Non-Ferrous Metals

Many of us know that metallic metal losses in melting non-

ferrous metals, especially those containing zinc or lead, are likely to be quite high, or at least are an important factor in determining casting costs, yet the cupola is used to melt copper, bronzes, including those containing as much as 10 per cent lead and brasses containing up to 5 per cent zinc.

High Alloy Castings

In the field of ferrous metallurgy, cast irons containing up to 25 per cent chromium, 20 to 40 per cent nickel, 11 to 14 per cent silicon are being produced in cupolas. In other words, if the cupola is a good melting possibility when such elements as manganese, silicon, copper, tin, chromium, lead, etc., are present in amounts of 10 per cent or more, it seems quite reasonable to assume that it is quite versatile and its full possibilities in the ferrous field are nowhere near fully explored.

"Oxidized Iron" Questionable

Those of us familiar with the Bessemer steel process know that it is a refining operation in which air is either blown through or over the surface of molten iron, removing silicon, manganese and carbon and that the end product is steel and not "oxidized iron." Having had some experience with the converter steel process, we have been unable to get very much excited when we occasionally hear the description "oxidized iron" in connection with the cupola product. There is so much protective element in cast iron, silicon, manganese, carbon that what is more likely to happen is that we have produced a metal lower in these elements than is suitable for our class of work rather than that we have produced "oxidized iron."

Changes in Iron on Melting in Cupola

In the cupola melting process, changes do take place in the chemistry of the iron, some because fuel and metal are in intimate contact and others because of the furnace characteristics. There is an increase in carbon and sulphur and a decrease in silicon, manganese and iron.

Melting Losses

The actual overall melting loss of the cupola is close to 2 or 3 per cent. The commonly used figure of 5 per cent includes the non-metallic material weighed in as part of the iron charge, metal losses through the slag hole and metal spattered around the foundry.

Silicon

Silicon losses are generally figured at 10 per cent of the amount of silicon charged but the actual losses vary from 5 to 30 per cent. Silicon losses are less with preheated air than with room temperature or outside temperature air. They are less with low silicon irons than with high silicon irons.

When the charge includes concentrated silicon alloys, such as silvery pig, silicon briquets or ferro-silicon, silicon losses are least when these materials are concentrated in one spot in the charge and when large chunks are used. For example, if we tapped four charges into one ladle, and needed to add 20 lb. of 50 per cent ferrosilicon to each charge, our silicon loss would be least if we added one 80-lb. chunk on one of the four charges and greatest when we added 20 lb. on each charge with pieces weighing one pound each.

Manganese

Manganese loss generally figures at 20 per cent, but the actual loss will vary widely, more widely than silicon.

Sulphur

The sulphur increase in cupola melting varies from 0.01 to 0.05 per cent. The sulphur increase is less with a high sulphur in the charge than with a low sulphur. Sulphur increase is more with steel containing charges than when no steel is used. The more the steel in the charge the more the sulphur increase. The more the surface area of the steel the more the sulphur increase. That is, a cupola charge containing 60 per cent steel rails would show a lower sulphur pickup than if the same quantity of sheet steel was used.

It is not practical to try to reduce sulphur in the cupola, but the amount of sulphur pickup can be held down more in an operation using 100 lb. of slag per ton of iron melted than in one using only 30 or 40 lb. of slag. The higher manganese content irons are likely to show a lower sulphur increase than the lower manganese irons.

Undoubtedly, we give sulphur more attention than the importance of the element warrants. It is probably true that a low sulphur iron makes a better grate bar than a high sulphur iron, but in general most of the good properties of cast iron are not seriously affected by the sulphur content. However, specifications are specifications and if you have one to meet you should do so or have the specifications modified to suit your normal sulphur ranges. In any event, ladle desulphurization may be used and specifications easily adhered to.

Carbon

The other element which changes during the melting process is carbon. A cupola charge containing 100 per cent of a high carbon pig iron would probably show a loss in carbon, but the carbon of most cupola charges is less than 3.25 per cent and may be as low as 0.75 per cent.

The amount of carbon that iron can hold in solution decreases with increasing silicon and phosphorus contents. That is, if you are trying to get a low carbon iron, you can do it easier if you can use a high silicon in the charge than if you have to use a low silicon iron.

The carbon increase in cupola melting increases with decreasing amounts in the iron charge. That is, with 3.0 per cent carbon in the charge the pickup might be 0.25 per cent, while with an 0.75 per cent carbon in the charge the pickup might be 2.0 per cent or more.

The various factors which influence the amounts of carbon that will be in the molten iron as tapped from the cupola are: (1) the amount of silicon and phosphorus in the charge; (2) the amount of carbon in the charge; (3) the characteristic of the coke used; (4) the amount of coke used; (5) the metal temperatures attained, and (6) the method of tapping the cupola.

The normal range of carbon in the cupola product is 3.00 to 3.50 per cent. The full range is from 2.0 to 3.8 per cent. Depressing the carbon range from 3.0 to 2.5 per cent is not very difficult provided a suitable fuel and a suitable practice are involved, but depressing the range from 2.5 to 2.0 per cent is more of a task.

When the cupola charge contains 20, 40, 60 and 80 per cent steel, respectively, one should be able to produce irons of 3.25, 2.90, 2.50 and 2.15 per cent carbon respectively.

Control of Carbon Range

Once a satisfactory carbon level has been established for the iron you wish to make, then the important job is to control the carbon range around the desired level to the least possible spread. Most foundrymen think little of a 30-point carbon spread and occasionally we find it as much as 100 points, or 1.00 per cent carbon. This spread may be controlled within 10 points in excellent cupola practice. Carbon has a profound influence on the quality of the iron produced and, once you are sure of the best carbon level for your product, every effort should be put forth to gain the utmost in carbon control. While many factors influence the various carbon levels attainable in cupola practice, the control of carbon at the desired level is largely limited to tapping variations.

As carbon is the most difficult element to control in cupola melting, it seems logical to expect that once operating details have been established that result in good carbon control other variations will also be under good control. Do not forget that the cupola tender may have as much to do with the quality of the product as the chemist or metallurgist and sometimes he has more.

It is possible that we may have disturbed you in referring to extremely low carbons and you may think that these carbons have very little interest to anyone dealing with cast iron. However, one section of our foundry industry has produced thousands of tons of cast iron in which the carbon content was as low as the lowest carbon we have mentioned and in many instances the carbon was much lower. We refer to the roll industry.

Importance of Accurate Weighing of Materials

It is good practice when we know that all materials charged into the cupola are weighed accurately and, strange as it may seem, it is one of the most difficult jobs to have done well. We bring the matter up in this discussion because in our work we have had our ears pinned back a few times because a single job of weighing was not done well.

A few years ago, the cupola charge contained two components, pig iron and scrap iron, probably 50 per cent of each, and the charged weighed, say, 4,000 lb. Weighing errors were relatively unimportant and the function of weighing was as much for inventory control and to let the foundry superintendent know when enough iron had been charged to pour off the floors as for any other reason. Today the cupola charge contains more than two components, as much as 12 in some foundries, and the charge probably weighs 2,000 lb. or less. Weighing is a matter of metallurgical control and weighing inaccuracies, due either to men or equipment, have a direct bearing on the quality of of your product. When you return home from this convention take time to check into the weighing of materials going into your cupola and we will gamble with you that a fair percentage of you will find the source of some of your foundry difficulties.

Pouring Temperatures

For some years we have been trying to figure out where cupola practice begins and ends, and for us it begins with the materials in the yard and ends after the mold has been filled with metal. The temperature of metal as tapped from the furnace is much less important to us than the pouring temperature. We have seen metal tapped at temperatures as low as 2500°F. and as high as 2900°F. and as far as we can tell, if metal at these two extremes of temperature were of identical composition and temperature at time of pouring, they would be equivalent in quality and in service.

When the pouring temperature of metal is low, it is true that the surface finish of the casting is superior to that where the pouring temperature is higher and for these castings, where surface finish is of greatest importance, the pouring temperature should be controlled to give the best results. In machinery castings, where the surface is of little importance and where good physical properties of microstructural control is paramount, then pouring temperatures should be in the higher ranges, generally above 2600°F. and sometimes as high as 2725°F.

Temperature Losses

It is not as easy as it sounds to pour metal into molds at 2600-2725°F., for metal temperature losses are generally more than one would think. These losses are due: (1) to the use of cold ladles; (2) to the use of ladles with light refractory linings; (3) to reladling metal from one ladle to another as much as three or four times; (4) to additions of cold materials to the ladle, and (5) returning ladles to furnace with metal in them.

Losses between the cupola spout and the mold are usually between 200 and 400°F., sometimes a little less than 200°F. and occasionally more than 400°F.

Most foundrymen believe they melt hot and pour hot, but it is quite likely that the metal temperature at the spout for the first few tons is not very hot and the pouring temperature for the first few ladles is likely to be 150°F. or more on the cold side of a good pouring temperature. We asked a foundryman to check some temperatures with us a few months ago; it was a good foundry and he checked his temperature with an optical pyrometer. He thought he was pouring at 2600-2700°F., but the first three ladles were poured at 2480 to 2450°F.

Some Sample Sand Testing Equipment

By Dr. H. Ries*, Ithaca, N. Y.

IN visiting different foundries, every now and then one sees some simple sand testing equipment which excites admiration for the ingenuity of the person who conceived it. The object sought, in many cases, is a desire to carry on sand control without having to purchase more expensive equipment.

A case in point is the sand testing outfit designed and constructed by C. H. Anderson, president, Hercules Foundries, Inc., Los Angeles, Calif., who has kindly supplied the illustrations and data.

Mr. Anderson has stated that the outfit was made from material picked up around the shop, supplemented by a few articles purchased from a large mail order house. It is used for daily sand control and gives fair satisfaction, even though it is not possible to express the results in standard units.

Fig. 1 shows the entire assembly. At the right is a homemade rammer. Next to it is an electric hot plate on which sets a small oven with thermometer for moisture determinations, and next to this is a pair of platform scales. At the left we see the apparatus for making permeability and green compression tests. The entire original outlay was a little over $20.00.

From Fig. 2, the mode of operation of the apparatus will be more clearly appreciated. To the right is shown a plan of the permeability apparatus. The air pressure in reservoir was originally supplied by a bicycle pump, but the apparatus is now connected with a low pressure air system. The reservoir is a gasoline drum.

At the left, the green compression apparatus is shown. The base plate, on which the specimen rests, is of stainless steel, and a similar plate is fastened to the base of the cylinder into which the water is poured. When the test piece is in place, a direct current is passed through it between the two steel plates. In this way, the moisture is measured, as the resistance varies with the amount of moisture.

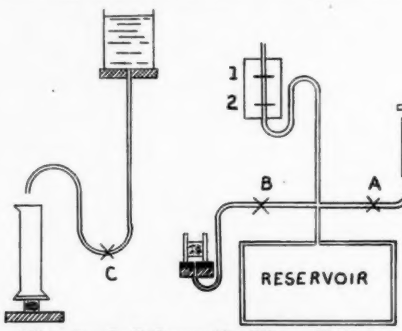


Fig. 2—A Schematic View Showing Mode of Operation.

Another interesting piece of apparatus for determining the strength of the sand mixture is that used by the Buckeye Steel Casting Co., Columbus, Ohio, and shown in Fig. 3.

The sample of green sand is rammed in the two piece tube *B*, which is held together by a ring fastened with a screw. The tube with rammed specimen is placed on a stand to left *(B¹)* and ring removed. The two buckets *(D)* are filled with water so that they balance. A wire is stretched from the top of *B¹* to *C*. Water is then drained from the left-hand bucket, thus disturbing the balance between the two buckets and causing the test piece to break. The strength is measured by the number of cubic centimeters of water removed from the left bucket. W. W. Heimberger, metallurgical engineer, states that the green bond values of their various mixes range from 150 to 250 when thus tested and that they normally check results within 5 cc. of each other.

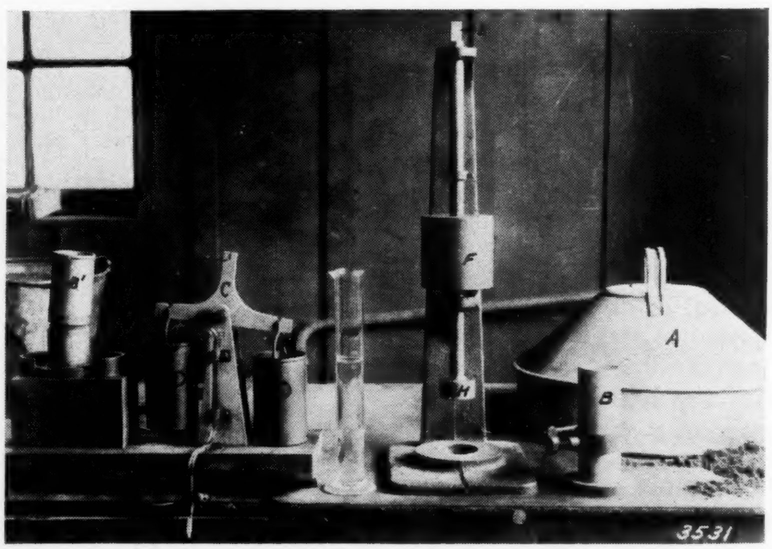
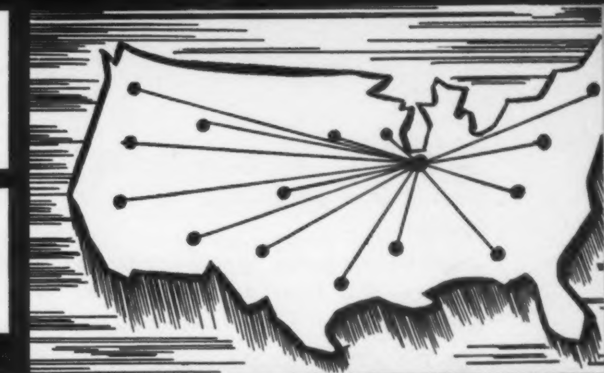


Fig. 3—Apparatus Used for Determining Strength of Sand Mixtures.

Fig. 1—Sand Testing Equipment Devised by C. H. Anderson.

*Technical director A.F.A. Foundry Sand Research committee.

Chapter Activities



Practical Foundry Problems Discussed at New England Meeting

By Merton A. Hosmer*, Boston, Mass.

ONE of the most interesting and informative meetings held by the New England Foundrymen's Association was the meeting of June 12 at the Engineers Club, Boston, Mass. Five speakers, well acquainted with the importance of the topics with which they dealt, had been assembled to speak on various phases of the foundry industry.

Following the dinner, President LeBarron, E. L. LeBarron Foundry Co., turned the meeting over to Charles Butler, Warren Pipe Co., who had charge of the evening's program. The program, as arranged by Mr. Butler, consisted of a panel discussion of practical, metallurgical and personal problems. The speakers, well-known to New England foundrymen, were chosen to be discussion leaders, each one preceding with a brief talk on a specific subject.

Porosity

Frank D. O'Connor, Walworth Co., South Boston, talked on the subject: "Porosity in Non-Ferrous Castings." He informed those present that wherever castings were subjected to pressure, porosity proved to be a very troublesome factor; several castings showing porosity were exhibited and the speaker explained how the various types of porosity came about. The importance of paying attention to details, both in melting and molding, as a remedy for porosity was stressed and then Mr. O'Connor went on to explain the importance of the size of the gates. He was able to show considerable improvement in certain types of castings by cutting down the size of the gate. Proper pouring temperatures also were discussed.

The next program speaker was Alfred Leavitt, Merriman Bros., Inc., Jamaica Plain. He was particularly interested in the manufacture of high grade bronze parts for yachts and boats, especially parts made of manganese bronze. The manufacturing of bronze parts to government specifications was related in this talk and a brief description was given of a high tensile strength manganese bronze, 110,000 lb., which is being manufactured by his company. Great stress was laid on the value of the pyrometer in maintaining good practice in bronze manufacture. In concluding his talk the speaker told of his interest in the organization end of the business, saying it was necessary not only to train the man under you, but to see that each worker has a chance to get ahead.

Discussion leader number three, Walter M. Saunders, Jr., Providence, R. I., took as his subject: "Combined Carbon in Cast Iron." He explained very accurately what carbon is and what its purpose was in cast iron. Mr. Saunders, in brief, stated that the amount of combined carbon formed in a casting depends upon the section size, or the cooling rate of the iron. The speaker added, in the same section size, the higher the silicon the lower the combined carbon. Emphasizing the fact to remember in connection with combined carbon, he asserted, that combined carbon is not a constant throughout the casting, and, therefore, the determination of it may be meaningless, if thought is not given to where and how the sample is taken.

Gating

"Gating of Castings" was the subject of the next lecture and was presented by A. S. Wright, Hunt-Spiller Mfg. Co., South Boston. Mr. Wright said that correct gates can eliminate, and incorrect gates can cause, many of the troubles encountered with castings. A correct gate should allow iron to enter into the mold easily and with a minimum amount of turbulence. This can be accomplished by watching a mold poured open occasionally to determine just what the effect of a gate is upon a stream of metal entering the mold. The speaker also called attention to the good results obtained in many instances where the practice of placing the runner in the cope, and the gates in the nowel, was employed.

The discussion led by John Whitin, Whitin Machine Works, Whitinville, was on "Machineability." A description of the machineability test which they have been using with some success was given. The test is based upon the time required for a definite sized drill, under a constant pressure and speed, to drill a certain distance into the casting. They had attempted to keep all these conditions constant, even the angle to which the drill was sharpened, and he showed several slides upon which were results justifying to the uniformity and practicability of the test. The speaker said that this test was not invented by them, but they had developed it for

*Reporter and Chemist, Hunt-Spiller Mfg. Co.

use in their own work and had been fairly successful in their results.

After each of the discussion leaders had concluded his talk, Mr. Butler asked for questions and discussions relating to the various subjects presented. The meeting proved to be a very profitable one for those present.

Foundrymen Enjoy Philadelphia Outing

By J. T. Fegley*, Philadelphia, Pa.

JUNE 12 was a gala day for foundrymen in the Philadelphia chapter area because 250 members and their guests met at the Hi-Top Country club, Drexel Hill, Pa., to enjoy a day of fun and relaxation. Mother nature cooperated with the chapter by giving them a day when they could thoroughly enjoy themselves playing baseball, tennis, golf, quoits and volleyball.

A delightful luncheon was served in the afternoon. Following the lunch attention was turned to the athletic contests, in which nearly everybody participated. At 7 o'clock supper was served and prizes were awarded to the winners of the various sports events.

It was a day of fun and frolic, and Jack Robb, chairman, entertainment committee, deserves much credit for the time and effort that he and his committee put forth to climax a most successful season.

*Chairman, Publicity Committee and Treasurer, North Bros. Mfg. Co.

Buffalo Holds Annual Stag Picnic

By J. R. Wark*, Buffalo, N. Y.

THE annual picnic of the Buffalo chapter, which is one of the highlights of the year for Buffalo chapter members, was run off June 15 without a hitch. Some 174 persons, both members and guests, were present to relish a day of fun and entertainment at Kudara's Farm, Hamburg, N. Y.

The program started with a delicious chicken dinner served to all those present. After the dinner Chapter Chairman Bill Corbett, Atlas Steel Casting Co., called the meeting to order and asked that the officers and directors, nominated to the offices for the forth coming year, be read and voted upon by the members in attendance. J. R. Wark read off the names of the nominated officers and directors, and as there was no other nominations made they were elected unanimously. The officers and directors elected are listed in the chapter directory of the July issue of *American Foundryman.*

After the meeting was adjourned the members were left to do as they pleased and to enjoy themselves making new and remaking old acquaintances. For the active members, who desired to work off some of the dinner, contests were staged. There were various forms of races, golf ball driving contests, baseball pitching contests and baseball games.

*Queen City Sand and Supply Co. and secretary, Buffalo chapter.

Northeastern Ohio Holds Annual Outing

By E. Bremer*, Cleveland, Ohio

DESPITE the inclement weather conditions which threatened the success of the Cleveland chapter's annual outing, some 250 members and guests gathered at Lake Forest Country Club, Hudson, Ohio, to participate in the fifth annual outing and golf tournament. Over 100 took part in the golf tournament.

The feature of the outing was the annual baseball game between the vendors and foundrymen. Second only to the national All-Star game, this contest turned out to be the fourth victory out of five games for the foundrymen.

A chicken dinner was served at 7 o'clock after which Ray Fleig, Cleveland chapter chairman, called on L. P. Robinson. Mr. Robinson in turn presented Leon Miller who announced and presented prizes to winners of the various events that were run off in the afternoon.

*Publicity chairman and Metallurgical Editor, "The Foundry."

I. L. Johnson, Chairman Northern California Chapter

Ivan L. Johnson, elected to head the Northern California Chapter for the coming year, is president Pacific Steel Castings Co., Berkeley, Calif. Born in 1895, in the area now embraced by the City of Oakland, he received his early education in the public schools, and like many of his predecessors in the steel industry, started his career at the bottom rung of the ladder. His first job, for a three year period, was with the Holt Mfg. Co., at San Leandro. Following this period he was with the C. L. Best Gas Traction Co., and then with the Best Steel Casting Co., which later was taken over by the General Metals Corp., with which he severed his connection in 1935. In that year he became associated with the Pacific Steel Casting Co., Berkeley, soon being elected president, the position he now holds.

On account of his years of training and interest in the business, he was called in 1930 to serve as vice chairman of Golden Gate Chapter, A.S.S.T., now known as American Society for Metals, serving as chairman in 1931, when the Western Metals Congress and Exposition was held in San Francisco. As one of the leading foundrymen in the district, Mr. Johnson is a member and alternate director of the Steel Founders' Society of America. He has been a hard worker in Northern California Chapter, American Foundrymen's Association since it secured its charter in 1935, and one of the organizers and a director of Northern California Foundrymen's Institute.

Cleveland Foundries Cooperate in Industrial Training Program

Cleveland industries, realizing the need for training of skilled and semi-skilled workmen to speed up production in connection with the National Defense Program, have formed an advisory and coordinating committee to work with the federal, state and local agencies. The coordinating committee was formed at a recent meeting of the personnel directors of some 30 of Cleveland's key industries, some of which are already working on defense program orders.

Subcommittees representing the various industries have been named. The functions of these committees are as follows: (1) to specify types and numbers of skilled and semi-skilled workmen required by local companies affected by the defense program and orders; (2) to advise and consult regarding training courses and type of machine instructions which will make men quickly available for production work; (3) to assist in obtaining equipment and machines needed in the training schools and; (4) to serve as a clearing house on labor shortages, training needs and related problems.

The foundry committee is under the chairmanship of George J. Leroux, assistant manager, National Malleable & Steel Castings Co., an active member of the Northeastern Ohio Chapter of A.F.A. and a member of the A.F.A. Committee on Foreman Training. Serving with Mr. Leroux are the following foundrymen: B. H. Aiken, Supt., Crucible Steel Castings Co.; R. C. Hamburg, Supt., Eberhard Mfg. Co.; Malcolm Love, Employment Mgr., Ferro Machine & Foundry Co.; F. W. Pascoe, Foundry Supt., Westinghouse Electric & Mfg. Co., and H. G. Wellman, Sec.-Treas., Wellman Bronze & Aluminum Co.

This foundry committee has sent a questionnaire to all foundries of Cleveland to determine in what particular foundry occupations shortages may exist. It is proposed that special foundry training will be given at the Cleveland Trade School, where the foundry work is under the direction of J. G. Goldie, who recently was appointed chairman of the A.F.A. Apprentice Training Committee, a committee on which Mr. Goldie has served faithfully for many years. Frank C. Cech, pattern instructor at the Cleveland Trade School, is also a member of the A.F.A. Committee.

The questionnaire to the foundries asks for information on numbers of bench, floor, squeezer and machine molders, core makers, wood and metal pattern makers, who are at present employed and the number who would have to be added under normal full operation and under high production schedules.

Similar training plans are being worked out in other localities, many of which are in A.F.A. chapter territories. This work is being stimulated through the efforts of the National Youth Administration in securing an extensive appropriation for the training of workmen.

Southern California Hears Ordnance Officer

By W. F. Haggman*, Los Angeles, Calif.

THE June meeting of the Southern California chapter was held the evening of the 27th at the Clark Hotel, Los Angeles. This meeting, the last in the year's series, was attended by over 90 members and guests, with chapter chairman A. G. Zima, International Nickel Co., opening the meeting. He then turned the meeting over to James E. Eppley, Kinney Iron Works, who was elected at the previous meeting to head the chapter for the coming year.

Chairman Eppley first introduced the other new officers and directors, Earl Anderson, Enterprise Foundry Co., as Treasurer and W. F. Haggman, Foundry Specialties Co., as Secretary. Then on behalf of the chapter he presented to the retiring chairman, Mr. Zima, an engraved ring as a token of appreciation for his splendid work in heading the chapter this past year. W. D. Bailey, Pacific Metals Co., Ltd., retiring chairman of the entertainment committee, when asked to speak presented the chapter with a fine new projection machine.

After a showing of several sound reels depicting the war in Finland, Poland and Holland, Chairman Eppley introduced, as the principal speaker of the evening, Major A. R. Baird, U. S. Army Ordnance, who spoke on "Industry and National Defense." Major Baird gave an interesting and timely account of the requirements and preparation for national defense, stressing War Department needs. He further discussed the part that foundries will play, showing that they will produce largely for subcontractors. The steel and non-ferrous foundries will be called upon more than gray iron foundries for direct armament material. The need for training to supply the demand for qualified, skilled labor was emphasized.

*Foundry Specialties Co. and Secretary, Southern California Chapter.

Chapter Directory Corrections

IT is regretted that in publishing the list of chapter directors and officers which appeared in the July issue, pages 18 and 19, the connection of A. W. Allen, director, Northern California chapter, was incorrect. Mr. Allen is with the Lincoln Iron Foundry. Under the Buffalo chapter, V. L. Whitehead, Jr., Whitehead Bros. Co., should have been shown as Treasurer, with Mr. Armstrong as Secretary. Under the Central New York chapter, J. W. Barker, Andes Range & Furnace Corp., Geneva, N. Y., is to be added to the directors.

Gating with Special Reference to the Optimum Flow Conditions in the Molten Metal

By Dr. E. M. H. Lips

This paper, which is reprinted from the Proceedings, Institute of British Foundrymen, vol. 32, pp. 77-81, 1938-39, was presented to the International Foundry Congress held in London, June, 1939, before a meeting of the Institute of British Foundrymen and was presented on behalf of the Nederlandsche Vereeniging van Gieterij-Technici (Netherlands Technical Foundry Association).

THE importance of the question concerning the manner in which the molten metal should be fed to a mold is too well known to every practical foundryman to require discussion here. It may, therefore, be regarded as characteristic that during the past few years attempts have been made to investigate more fundamentally the processes which take place during the filling of molds and thus to break away from the previous custom of describing the effects produced on the quality of the casting by interfering with foundry practice.

Flow Dynamics

It is now recognized that the application of important conclusions made in related subjects will generally insure a satisfactory result. It is also an obvious step to apply the laws of flow dynamics in the foundry where liquid metal is handled, especially since the importance of flow dynamics was first proved in hydraulics and later in airplane design. The application of the principles of flow dynamics at a relatively late date in foundry practice may be explained as being due to the fact that through the use of molding boxes the flow of the metal through the mold is not visible to the eye, so that it is more or less impossible to observe the phenomena which occur during pouring. The present paper is intended to draw attention to some laws of flow which are important for foundry practice and which permit general rules to be established for the design of casting gates.

For the purpose of considering the process of pouring metal into a mold, the latter may be subdivided into three parts:—

(1) All the channels through which the molten metal has to pass before entering the mold proper.

(2) The mold proper.

(3) The channels provided for the purpose of obviating the effects of cooling phenomena, such as the formation of cavities, after the mold has has been filled with the molten metal.

It is clear that the channels mentioned under (1) have primarily to satisfy hydrodynamical requirements, while the channels mentioned under (3) have nothing to do with the flow of the molten metal, but are only operative after the molten metal has come to rest.

Consideration therefore will be confined almost exclusively to the channels mentioned under (1). Fig. 1 shows two runners on top of which is placed a pouring bush. If the bush is filled,

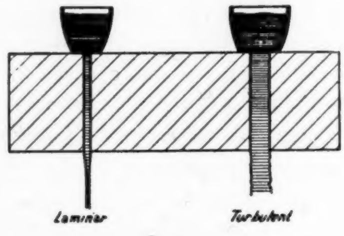


Fig. 1—Small and Large Diameter Runners Giving Laminar and Turbulent Flow Respectively.

for example, with molten iron and the stopper is removed, the iron will flow through the runner into any cavity located beneath. If the diameter of the runner in the case of one mold is small, for example, 4 mm. (0.15748 in.), and in the case of the other is large, for example, 40 mm. (1.57480 in.), it is found that the nature of the flow from the exit is very different in the two cases.

The molten metal issues from the runner of larger diameter in the form of a very turbulent and unsteady flow, while a very steady and smooth-exit flow occurs in the case of the runner with the smaller diameter. The metal flowing through the runner of large diameter produces considerable frothing in any receptacle situated beneath it, while the same metal flowing through the channel of small diameter causes practically no frothing. In the case of molten aluminum, this difference is, if possible, even more pronounced.

Size of Runners

The differences outlined above may be fully explained by reference to Fig. 2. The flow of the metal through a channel or runner of small diameter is laminar or streamline, that is to say, the mean velocity of the flowing metal is a maximum in the center and approaches zero at the wall of the channel. The curve showing the distribution of the velocity is a parabola. The flow of the metal passing through the runner of large diameter is, on the contrary, turbulent, that is to say, the mean velocity of the flowing metal is almost constant throughout the entire cross-section of the channel.

If a particle moving in laminar flow be considered, its path is found to be rectilinear. In the case of a particle moving in turbulent flow, on the contrary, its motion takes place along wholly irregular and curved paths. If the flow of metal

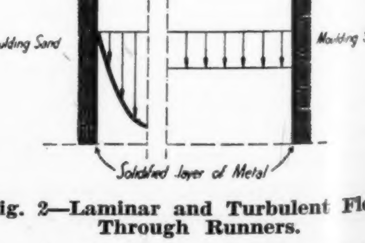


Fig. 2—Laminar and Turbulent Flow Through Runners.

through a pouring gate is streamline, the thin film solidifying on the wall of the gate will remain intact, because the velocity of the flowing metal is practically zero along the wall. The sand of the mold is thus protected by a film of solidified metal.

In the case of turbulent flow, a film of solidified metal will likewise be formed, but will be partly detached by the metal flowing along it at a considerable velocity and will take particles of sand along with it. With turbulent flow, a slight suction is also produced in places, in consequence of which gases present in the material of the mold are carried along and contaminate the metal. It is clear that this will result in the formation of dirt which can practically no longer be removed. This may be expressed as follows:—Laminar or streamline flow prevents the formation of dirt, while turbulent flow promotes such formation.

Attaining Laminar Flow

The question which now arises is, therefore: How can laminar flow be attained or at least approached more closely? The nature of the flow of any liquid through a channel or pipe depends directly upon the velocity V_o [m.sec.$^{-1}$], the pipe diameter d [m.] and the kinematic viscosity ν (nu) [m^2.sec.$^{-1}$]

$$R = V_o \frac{d}{\nu} \quad . \; . \; . \; . \; . \; . \quad (1).$$

For smooth runner or "pipe" walls, flow is only laminar when $R \leq 2{,}500$. For greater values of R, the flow is turbulent. It will be seen that V_0 and d denote values depending upon the dimensions of the mold, while ν is a constant of the material. Assuming for cast iron a viscosity of $200 \, . \, 10^{-6}$ [kg.sec.m.$^{-2}$], then

$$\nu = \frac{200 \, . \, 10^{-6}}{715} = 0.28.10^{-6} \text{ [m}^2\text{.sec.}^{-1}\text{]}.(2).$$

Taking the limit value of R as 2,500, it is possible to calculate, for example, for a given pipe diameter, the permissible velocity of the liquid which just produces laminar flow. This velocity is also called the critical velocity. The curve in Fig. 3

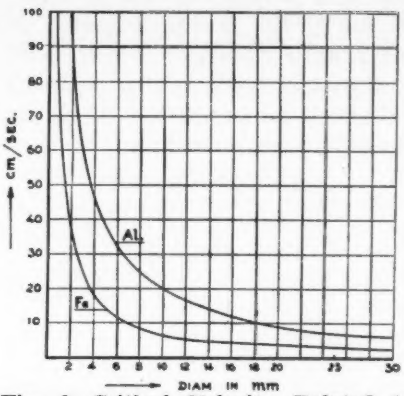


Fig. 3—Critical Velocity Related to Diameter of Runner for Iron and Aluminum.

shows these relationships. Although the viscosity of aluminum is not yet known, a curve has also been given for this metal on the assumption that the viscosity is approximately the same as that of iron. The fundamentally more satisfactory behavior of light metals with regard to running power may be gathered from these curves.

Pouring Gate Design

It can furthermore be deduced from Fig. 3 that the diameter of the pouring gate must be small for attaining laminar flow. This is the chief reason why a pouring gate should not be combined with a riser. For well-known reasons, risers must always be of large diameter.

It may also be said that the pouring gate must be designed on purely hydrodynamical principles, while the design of the riser is governed by the crystallization properties of the cast material when at rest. The importance of the hydrodynamical design of the gating system will also be apparent from the following requirements which a good gating system should satisfy, for a small pouring gate diameter is not everything.

Fig. 4 shows the variation of the velocity of the metal flowing through the pouring gate with the pressure. Curves *a*, *b* and *c* show the loss of pressure, relative to the velocity of the liquid, which occurs when the molten metal undergoes a change in direction of 90°.

These curves were constructed on the following basis: If the resistance which the change in direction offers to the flow is equal to ζ (zeta), then

$$\zeta = \frac{\Delta p}{V_o^2 \, . \, \frac{\rho}{2}}$$

where Δp [kg. m.$^{-2}$] = loss in pressure caused by the change in direction.

V_0 [m. sec.$^{-1}$] = velocity of the flowing liquid.

ρ [kg. sec.^{2} m.$^{-4}$] = specific gravity.

For a sharp bend of 90° with a rough surface, Kirchbach and Schubert found a value of 1.27 by measurement. For a bend with a radius of curvature equal to the diameter of the pipe (curve *b*), this value is 0.50. For a radius of curvature equal to six times the diameter of the pipe (curve *c*) the value is 0.18. Although it should be definitely stated that these figures are not

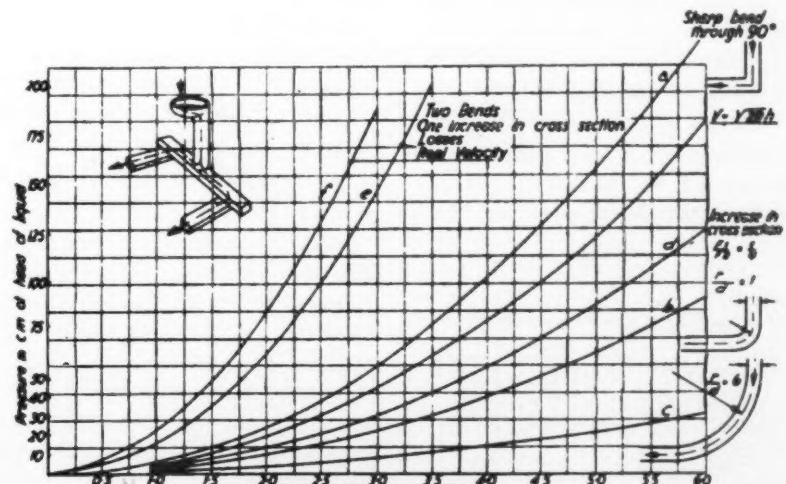


Fig. 4—Variation of Velocity of Metal Through the Pouring Gate with Pressure.

applicable to the flow of molten metal through a much cooler pouring gate, it is permissible to employ the value n for purposes of comparison, especially since the comparisons developed in hydrodynamics are also substantially applicable to liquids such as molten metal, while no values are yet known in the literature for correcting the above-mentioned numerical values.

It will be gathered from Fig. 4 that, for example, at a velocity of 3 metres (9.8 ft.) per second, the loss in pressure head for a sharp bend (curve *a*) is about 60 cms. (24-in.). For a curvature such as that given by the curves *b* and *c*, this loss is reduced to 20 cms. (8-in.) and 8 cms. (3-in.) respectively. This clearly shows the significance of the gate known as the horn gate.

It is necessary to avoid not only a sudden change in direction of the flowing metal, but also abrupt changes in the cross-section of the gate, the loss in the case of a sudden increase in cross-section being particularly noticeable. Curve *d* shows the loss for a sudden increase in cross-section of one-quarter. The curve was plotted for a value of ζ of 0.7. Of course, the restricting condition mentioned above also applies in this case. Assuming now that there are two sudden changes in direction and a sudden increase in cross-section in a gating system (the example indicated in Fig. 4 shows the possibility of this condition), the losses may then be represented by the curve *e* and the actual velocity by the curve *f*. In the example cited, for a gate 100 cms. (40-in.) in height, for instance, the theoretical velocity as calculated from the equation $V = \sqrt{2gh}$ would be about 4.5 m. per sec. (18 ft. per sec.), while the actual velocity is only 2.2 m. per sec. (7.5 ft. per sec.), giving a factor of usefulness of about 50 per cent. Compared with corresponding data in the literature, this figure appears quite possible.

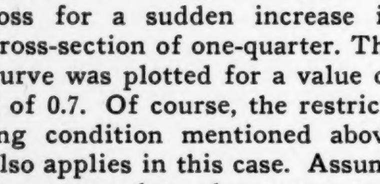


Fig. 5—Common Gating System (Left) and Suggested Improvement (Right).

Practical Examples

It will now be of interest to illustrate the application of the above theory with reference to some examples. The left-hand portion of Fig. 5 shows a gating system which is in common use. It will be seen that not only is there a repeated change in direction, but there are also sudden changes in cross-section. In the right-hand portion of Fig. 5, the single pouring gate has been replaced by a large number of thin gates. Changes in cross-section and direction are avoided as much as possible, while the gate diameter is also very small. The satisfactory effect of "pencil gates" employed in some quarters may thus be explained.

The right-hand portion of Fig. 6 shows a gating system provided with what are called "dirt traps." From the foregoing, it will be clear that the writer is not an advocate of such dirt traps, which merely set up resistance and turbulence. This system can be very successfully replaced by the arrangement shown on the left in Fig. 6, which corresponds better to satisfactory flow conditions.

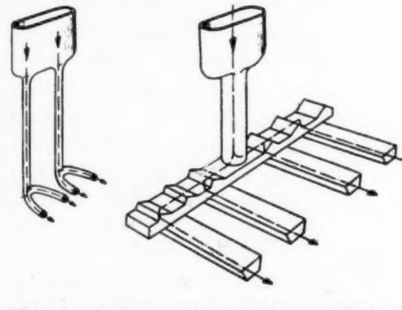


Fig. 6—Gating System with Dirt Traps (Right) and an Improved System (Left).

Fig. 7 shows two diagrams of the same casting. On the left, it is provided with the usual gating system, and on the right with a system of new design. The numerical values shown in the figure indicate the cross-sections of the various channels in square millimetres. The small diagram shows the variation in cross-section. Comparison of the two gating systems will clearly show that not only have sudden changes in direction been avoided as much as possible, but also sudden variations in cross-section, thus resulting not only in an improvement in the quality of the casting, but also in a considerable reduction in the weight of the gates and runners.

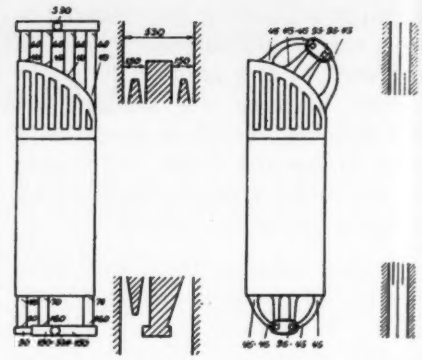


Fig. 7—The Same Casting Provided With Conventional Gating System (Left) and Improved System (Right).

Book Review

The Machining of Copper and Its Alloys, published by the Copper Development Association, Thames House, Milbank, London, S. W. 1, 6x9, 108 pp., 43 illustrations, 20 tables, cloth binding.

The purpose of this book is outlined in its title. The first section deals with a classification of copper-base alloys, dividing them into three groups as follows: (a) Honogeneous materials, (b) duplex or complex alloys (lead free), and (c) leaded alloys. Such operations as turning, shaping, planing, facing, drilling, boring, reaming, tapping, milling, sawing, broaching and grinding are discussed. Considerable information is given on tool design, rigidity of tools, cutting tool materials, speeds and feeds and cutting fluids. In the appendix are given several tables, one of which gives the relation between cutting speed, work diameter and r.p.m. A chapter of some importance appears to be the one devoted to the selection of copper alloys for machine purposes.

NEW MEMBERS

In the July American Foundryman, the first announcement of Sustaining memberships was published showing 47 companies which had taken advantage of this recently authorized type of membership, presenting an opportunity to support the Association in proportion to benefits accruing and their desire to further the aims and purposes of the A.F.A. It is now gratifying to report that 23 additional firms have changed their previous Company membership status to that of Sustaining members, 11 being from the Wisconsin Chapter, bringing its total of Sustaining members to 15. Second in the roll of this new classification is the Northeastern Ohio Chapter with a total of 12. It is with sincere appreciation that acknowledgement is made to these companies which are:

New Sustaining Members

Chas. G. Allen Co., Barre, Mass.
Allis-Chalmers Mfg. Co., Milwaukee, Wis.
American Steel & Wire Co., Cleveland, Ohio
Apex Smelting Co., Chicago, Ill.
Brown & Sharpe Mfg. Co., Providence, R. I.
Chain Belt Co., Milwaukee, Wis.
Chicago Retort & Fire Brick Co., Chicago, Ill.
Cincinnati Milling Machine Co., Cincinnati, Ohio
Federated Metals Div., American Smelting & Refining Co., St. Louis, Mo.
Hoosier Iron Works, Kokomo, Ind.
Liberty Foundry, Inc., Wauwatosa, Wis.
Lynchburg Foundry Co., Lynchburg, Va.
Milwaukee Foundry Equipment Co., Milwaukee, Wis.
Milwaukee Malleable & Grey Iron Works, Milwaukee, Wis.
Motor Castings Co., West Allis, Wis.
Nordberg Mfg. Co., Milwaukee, Wis.
Overmyer Mould Co., Winchester, Ind.
George F. Pettinos, Philadelphia, Pa.
Quality Aluminum Casting Co., Waukesha, Wis.
Standard Foundry Co., Racine, Wis.
Waukesha Foundry Co., Waukesha, Wis.
Wisconsin Appleton Co., South Milwaukee, Wis.
Woodward Iron Co., Woodward, Ala.

In the July issue 112 new members were reported for the period May 3 to June 11. From June 11 to July 12 one hundred more new members are here reported. To the Birmingham District Chapter goes the distinction of showing 44, the greatest number to be recorded in any similar period since the chapters were organized.

Birmingham Chapter

S. L. Anderson, Foreman, Central Foundry Co., Holt, Ala.
S. Andrews, Central Foundry Co., Holt, Ala.
Anniston Foundry Co., Anniston, Ala. (C. H. Deyo, President)*
W. Thomas Barr, American Cast Iron Pipe Co., Birmingham, Ala.
J. V. Blackman, Supt., By-Product Plant, Sloss-Sheffield Steel & Iron Co., Birmingham, Ala.
Tom Bonds, Supt., Alabama Pipe Co., Union Foundry, Anniston, Ala.
C. P. Caldwell, President, Caldwell Foundry & Machine Co., Birmingham, Ala.
A. W. Claussen, Ass't. Works Mgr., McWane Cast Iron Pipe Co., Birmingham, Ala.
O. D. Clements, Foreman, Central Foundry Co., Holt, Ala.
Cox Foundry & Machine Co., Birmingham, Ala. (Margaret W. Nichols, Vice-President)*
Harry Craig, Foreman, Central Foundry Co., Holt, Ala.
Leon Ehrman, Supt., Sloss-Sheffield Steel & Iron Co., Birmingham, Ala.
Leslie Fisher, Foreman, Central Foundry Co., Holt, Ala.
Gadsden Iron Works, Inc., Birmingham, Ala. (Wm. B. Neal, President)*
H. C. Goodwin, Foreman, Central Foundry Co., Holt, Ala.
Clarence Harmon, Foreman, Alabama Pipe Co., Standard Foundry, Anniston, Ala.
H. B. Hastings, Foreman, Republic Steel Corp., Birmingham, Ala.
A. C. Herndon, Supt., Alabama Pipe Co., Standard Foundry, Anniston, Ala.
Joseph L. Hill, Melting Foreman, Continental Gin Co., Birmingham, Ala.
J. S. Landers, Chemist, Central Foundry Co., Holt, Ala.
R. E. Latham, Foreman, Central Foundry Co., Holt, Ala.
W. P. Lockridge, Foreman, Central Foundry Co., Holt, Ala.
H. W. Matthews, President, Matthews Electric Co., Birmingham, Ala.
Walter H. Miller, Owner, Miller Foundry Co., Birmingham, Ala.
Ray Moore, Office, Central Foundry Co., Holt, Ala.
J. H. Owen, Foreman, Central Foundry Co., Holt, Ala.
J. J. Reynolds, Jr., Ass't to Mgr., U. S. Pipe & Foundry Co., Bessemer, Ala.
L. F. Rhodes, Supt., Alabama Pipe Co., Talladega Foundry, Talladega, Ala.
A. C. Roberts, Supt., Alabama Pipe Co., Anniston, Ala.
C. W. Robertson, Foreman, Central Foundry Co., Holt, Ala.
J. O. Rogers, Foreman, Central Foundry Co., Holt, Ala.
E. N. Rooks, Supt., Alabama Pipe Co., Rudisill Foundry, Anniston, Ala.
J. C. Shewmake, Foreman, Central Foundry Co., Holt, Ala.
J. P. Singleton, Safety & Personnel, Central Foundry Co., Holt, Ala.
Milton C. Smith, Hill & Griffith Co., Birmingham, Ala.
H. T. Sommerhill, Foreman, Central Foundry Co., Holt, Ala.
Will Taylor, Foreman, Central Foundry Co., Holt, Ala.
Tennessee Products Corp., Nashville, Tenn. (C. McFarlin, President)*
J. K. Travis, Salesman, Hickman, Williams & Co., Birmingham, Ala.

*Company members.

Dick Waugh, Foreman, Alabama Pipe Co., Union Foundry, Anniston, Ala.
A. J. Weller, Foreman, Central Foundry Co., Holt, Ala.
E. M. Whelchel, Metallographer, American Cast Iron Pipe Co., Birmingham, Ala.
J. H. White, Republic Steel Corp., Birmingham, Ala.
W. S. Wilson, Treasurer, Sloss-Sheffield Steel & Iron Co., Birmingham, Ala.

Buffalo Chapter

Leo F. Geary, Fdry. Inspector, Clark Bros. Div., Dresser Mfg. Co., Olean, N. Y.
A. J. Heysel, Branch Mgr., E. J. Woodison Co., Buffalo, N. Y.
R. Kingston, Foreman, The Symington-Gould Corp., Rochester, N. Y.
W. L. Straube, Foreman, The Symington-Gould Corp., Rochester, N. Y.

Central Indiana Chapter

C. Paul Huge, Salesman, Republic Steel Corp., Indianapolis, Ind.

Central New York Chapter

Edmund Jones, Iron Fdry., Foreman, The Fairbanks Co., Binghamton, N. Y.
Frank Moss, Bronze Fdry., Foreman, The Fairbanks Co., Binghamton, N. Y.

Chicago Chapter

Aeromotor Co., Chicago, Ill. (L. C. Walker, President)*
H. O. Degner, Dist. Mgr., Aerovent Fan Co., Chicago, Ill.
Electrocast Steel Foundry Co., Cicero, Ill. (Oscar G. Peterson, Vice-President)*
Hunter Foundry Company, Inc., Chicago, Ill. Walter Hunter, President)*
Milton E. Johnson, Ass't Mgr. of Field Force, Whiting Corp., Harvey, Ill.
R. O. Johnson, Industrial Relations Dept., International Harvester Co., McCormick Works, Chicago, Ill.
Fred B. Marshall, Foreman, Continental Roll & Steel Foundry Co., East Chicago, Ind.
Richard L. Pope, Metallurgical Ass't, American Manganese Steel Div., American Brake Shoe & Foundry Co., Chicago Heights, Ill.
George Robb, Molding Foreman, Burnside Steel Foundry Co., Chicago, Ill.
George E. Weber, Foreman Core Room, Burnside Steel Foundry Co., Chicago, Ill.
Harvey H. Weber, Prod. Mgr., Burnside Steel Foundry Co., Chicago, Ill.

Detroit Chapter

E. G. Brewer, Salesman, Taggart & Co., Huntington Woods, Mich.
Carleton W. Greaves, Night Fdy. Supt., United States Radiator Corp., Detroit, Mich.
D. E. Hensley, Supt., Southern Wheel Div. of American Brake Shoe & Fdy. Co., Toledo, Ohio

Metropolitan New York-New Jersey Chapter

W. S. Fraula, Works Mgr., American Brake Shoe & Foundry Co., New York, N. Y.
James H. Ferguson, Metallurgical Ass't., American Brake Shoe & Foundry Co., Mahwah, N. J.

Metropolitan Philadelphia Chapter

G. F. Ebeling, Dodge Steel Co., Philadelphia, Pa.
R. C. Hutchison, Refractory Engr., Bethlehem Steel Co., Bethlehem, Pa.

Michiana Chapter

Donald G. Cripps, Clark Equipment Co., Buchanan, Mich.
Roy C. Hoover, Melter, Clark Equipment Co., Buchanan, Mich.
Harry J. Lyle, Inspector, Clark Equipment Co., Buchanan, Mich.

Northeastern Ohio Chapter

John Eugene Jackson, Metallurgical Engr., Copper Iron and Steel Development Ass'n., Cleveland, Ohio.
J. L. Presby, Ass't Resident Inspector, National Malleable & Steel Castings Co., Cleveland, Ohio

Northern California Chapter

H. H. Hagedorn, Salesman, Pacific Abrasive Supply Co., San Francisco, Calif.
J. G. McCallum, Consulting Metallurgist, Oakland, Calif.

Ontario Chapter

John Victor Newton, Metallurgist, Anaconda American Brass, Ltd., New Toronto, Ont., Canada
Taylor-Forbes, Ltd., Guelph, Ont., Canada (S. C. Evans, Managing Director)*

Quad-City Chapter

J. E. Kolb, Pattern Shop Supt., Caterpillar Tractor Co., Peoria, Ill.

St. Louis Chapter

E. J. Aubuchon, Sec'y-Ass't. Treas., M. A. Bell Co., St. Louis, Mo.
Ralph Prisk, Salesman, Ingersoll-Rand Co., St. Louis, Mo.
Lawrence M. Reilly, Service Mgr., National Bearing Metals Corp., St. Louis, Mo.
James Roland, Sec'y., Fry-Fulton Lumber Co., St. Louis, Mo.
S. C. Thomson, Salesman, Federated Metals Div., American Smelting & Refining Co., St. Louis, Mo.
John Williamson, Salesman, M. A. Bell Co., St. Louis, Mo.

Wisconsin Chapter

Pollard Oil Products Co., Milwaukee, Wisconsin (M. A. Pollard, President)*
Harry J. Schofield, Manager, Fire Brick Engineers, Inc., Milwaukee, Wis.
W. Douglas Stewart, Salesman, Ingersoll-Rand Co., Cudahy, Wis.
Vilter Manufacturing Co., Milwaukee, Wis. (Fred T. Goes, Vice-President & Works Mgr.)*

Outside of Chapters

Aerovent Fan Co., Piqua, Ohio (Martin W. Bauer, Vice-President)*
John Raymond Berry, Ass't Mgr., Hoskins Foundry Ltd., Perth, Western Australia
Stanley W. Brinson, Master Molder, Norfolk Navy Yard, Portsmouth, Va.
Thomas E. Eagan, Chief Metallurgist, Cooper-Bessemer Corp., Grove City, Pa.
Director Talleres Generales, Base Naval, Puerto Belgrano, Argentine Republic.
Joseph H. Houston, Gen'l Foreman, Walworth Co., Greensburg, Pa.
C. Y. Lee, Mech. Engr., Yungli Chemical Industries, Wu-tung-Kiao, Szechwan, China.
William H. Owen, Research, Valley Mould & Iron Corp., Hubbard, Ohio
P. J. Potter, Vice-President, Pangborn Corp., Hagerstown, Md.
Pyle Pattern & Mfg. Co., Muskegon Heights, Mich. (Adam Pyle, Jr., Sec'y-Treas.)*
Carl Ultes, Jr., Research, The O. S. Kelly Co., Springfield, Ohio.

*Company members.

ABSTRACTS

NOTE: The following references to articles dealing with the many phases of the foundry industry, have been prepared by the staff of *American Foundryman*, from current technical and trade publications.
When copies of the complete articles are desired, photostat copies may be obtained from the Engineering Societies Library, 29 W. 39th Street, New York, N. Y.

Aluminum

EUROPEAN PRACTICE. *"Aluminum Alloy Practice in Europe,"* Ernest V. Pannell, *The Iron Age*, vol. 145, no. 24, June 13, 1940, pp. 25-29. Contained in this article is a description of the aluminum casting alloys used in Britain and the continent. The various types of additive elements and the uses to which alloys are put are related. Included is a very informative list of some 70 alloys, their composition and some of their general physical characteristics. (Al.)

HEAT-TREATMENT. *"Heat-Treatment of Light-Alloy Castings,"* by H. G. Warrington, *Foundry Trade Journal*, vol. 62, no. 1240, May 23, 1940, pp. 385-386, 388. An attempt has been made, in this paper, to show the necessity for an understanding of the general metallurgical principles of aluminum alloys for the successful conduct of a heat-treatment department that is to cope with a wide variety of materials and components. At the same time, the author has endeavored to give some idea of those subjects which are of interest to the heat-treatment technician and the effect of his knowledge on the design and use of castings, in the hope that a little more thought may be given to this type of work. (Al.)

REFRACTORY BRICK. *"Effect of Molten Aluminum on Various Refractory Brick,"* by H. O. Burrows, *Journal, American Ceramic Society*, vol. 23, no. 5, May, 1940, pp. 125-133. This test was made to study the effect of molten aluminum on refractory brick with a view toward explaining some of the brick failure in aluminum melting furnaces. Bricks from various manufacturers, and of different composition, were placed on end in the bottom of an electrically heated ladle to which molten aluminum was added. The aluminum was left in contact with the brick for 35 days, it was then poured off and the ladle was allowed to cool down to room temperature.

The tests showed that there was the least reaction between aluminum and the chrome brick and the most between the aluminum and the silica brick. However, there are many other factors to be considered when deciding which brick is the most economical to use in aluminum melting. (Al.)

Beryllium

ALLOYS. *"Beryllium and Some of Its Aluminum Alloys,"* by C. B. Sawyer and B. Kjellgren, *Metals and Alloys*, vol. 11, no. 6, June, 1940, pp. 163-167. Not many articles on beryllium and its alloys have been written or published, but a great deal of interest is shown in this metal and it is expected that many uses, for it and its alloys, will soon be developed. The metallurgy of the metal is being studied and the metal and its alloys are in the early stages of its development, and so rapid progress can be expected along many lines. The authors present some of the properties of the pure metal, its ability to be cast or forged, the properties of the metal when alloyed with aluminum or manganese and some of the uses to which this metal has been applied. (Al.)

Casting

NICKEL SILVER. *"Producing Castings of Nickel Silver,"* by D. M. Curry, *The Foundry*, vol. 68, no. 6, June, 1940, pp. 46-47, 123-127. Nickel silver castings can be produced readily in the foundry, providing one or two facts of a fundamental nature are understood. Nonferrous alloys containing appreciable quantities of nickel are all susceptible to gas absorption during the melting period. Precautions must be taken against such an action by rapid melting nickel silver in a slightly oxidizing atmosphere. If this is ignored, castings with varying degrees of porosity will result. The melting technique is very valuable since hydrogen that combines with the nickel-copper base metal will have a grave effect on the quality of the castings produced. Having adopted the correct melting conditions it is still essential to give proper consideration to problems of composition, deoxidation treatment, pouring temperature and molding methods if satisfactory castings are to be produced. (C. Also Nickel Silver.)

Cast Iron

CONTRACTION. *"Some Observations on Contraction in Gray Cast Iron,"* by E. Longden, *Foundry Trade Journal*, vol. 62, no. 1243, June 13, 1940, pp. 432-434, 438. The term "contraction in cast iron" is used in this paper to define the reduction in volume which operates from the point of solidification to atmospheric temperature. The amount of contraction and degree of distortion in a casting will have relationship to the chemical and physical properties of the metal, design and method of manufacture. Because a large casting offers a wider and bigger field for observing movements during cooling than small castings, or test-bars, the author's attention has been directed to following the movements of large castings during cooling. The data presented in this paper will indicate that final contraction and the absence or presence of stresses in many classes of castings are due to the conflicting expansion and contraction influences operating together in the same casting. A method devised by the author for ascertaining the behavior of large castings during cooling, from the point of solidification to atmospheric pressure, is shown. The test procedure is also discussed. Tests were conducted on large boring bar castings and the results are reported from the investigations. (C.I.)

HEAT TREATMENT. *"The Heat Treatment of Cast Iron,"* by Dr. J. E. Hurst, *Pig Iron Rough Notes*, no. 80, Spring, 1940, pp. 5-12. The examination of quenched and tempered cast iron specimens under the microscope shows that, as in the case of steels, the hardening effect is due to the formation of martensite, and the effect of tempering, at successively higher temperatures, is accompanied by a gradual change from the martensite to sorbitic structures. The investigation also deals with graphite and gives some interesting conclusions on the improvement of mechanical properties through the structural condition of graphite. The improvement in properties is not entirely due to graphite structure, as the author shows the influence that alloy additions have on cast iron properties. The outstanding elements used were nickel, manganese, chromium and molybdenum. It was found that these elements had the same effect on cast iron, in relation to their influence on the critical points and the critical speed of quenching, as they did on steel. The paper then covers the effect that the alloying elements had on the irons as they were used in the investigation. The effect of certain alloy additions in increasing the critical quenching speed can be taken advantage of in the production of alloy cast irons suitable for air-hardening treatments. (C.I.)

PEARLITE. *"The Decomposition of Pearlite in Gray Cast Iron,"* by A. A. Timmins, *The Iron and Steel Institute Paper*, May, 1940, pp. 1-18. This is the study of some of the conditions governing the decomposition of pearlite in gray cast irons. Three irons, differing only in silicon content, were heated at constant temperatures for various periods of time. Parts of the corresponding bars in the annealed condition were also heated in the same manner. Data were obtained which confirm the assumption that the removal of pearlite, on annealing at constant temperature, depends on the diffusion of carbon through the iron. The results show that combined carbon can be moved quite readily by annealing at temperatures below the critical point of the iron, the rate of removal being more rapid the nearer the heating temperature is to the critical point. It is also shown that heating at temperatures above the critical point may or may not remove combined-carbon, depending on whether or not the combined-content is above or below the equilibrium percentage. When heating at these temperatures the rate of cooling is the major factor in the removal of pearlite, while the duration of the soaking is the most important point to be considered when heating at temperatures below the critical point. (C.I.)

QUALITY. *"Making Better Cast Iron," Canadian Metals and Metallurgical Industries*, vol. 3, no. 5, May, 1940, pp. 118-120, 123. This review touches upon some of the points of outstanding interest in papers presented at the 44th annual A.F.A. convention. Papers are miscellaneous in nature and cover many subjects on general foundry practice and the production of cast and malleable iron. These papers canvass a wide field in that they include general techniques, specific shop practices, properties secured, causes of defects and many other problems found in day to day shop operation. (C.I.)

SOUND CASTINGS. *"Producing Sound Castings in Iron,"* by P. D. Pincott, *Foundry Trade Journal*, vol. 62, no. 1242, June 6, 1940, pp. 417-419. The object of this paper is to review and examine as closely as possible some of the difficulties connected with unsoundness in cast iron, and selecting, as specific examples to illustrate the cause and effect of this trouble, several castings produced by the company of which the author is associated. This paper is not intended as a comprehensive study made of such problems as are experienced throughout the entire range of cast irons, but rather it is intended to rather concentrate on the group of mod-

erately low-carbon and low-phosphorus irons which are used to a great extent in engineering where pressure and arduous working conditions prevail. (C.I.)

STRENGTH. *"The Strength of Steel and Cast Iron,"* by M. G. Corson, *The Iron Age,* vol. 145, no. 25, June 20, 1940, pp. 32-35. This paper presents a filament theory for steel and cast iron and gives an empirical formula for determining maximum possible tensile strength. The ideas that the author has set forth in his paper are quite controversial, but are very interesting. His ideas may cause other metallurgists to do some active thinking along similar lines of this same subject. (C.I.)

WELDING. *"Welding of Cast Iron"* by L. Tibbenham, *The Iron Age,* vol. 145, no. 25, June 20, 1940, pp. 36-38. Quite a few years ago it was considered impossible to weld cast iron satisfactorily, due to its peculiar structure, but recent evidence disproves this theory. This article gives the various problems encountered in the welding of cast iron, and describes in detail several techniques that have resulted in satisfactory welds. The steps of welding are explained in detail, such as preparing the casting which is to be welded, the methods to be used in preparing the casting, welding technique, the after-treatment of welds, etc. A few interesting notes on bronze welding are also advanced by the author. (C.I.)

Cast Steel

ALLOY ADDITIONS. *"Cast Steel—Effect of Additions on Quality,"* by C. H. Lorig, *Product Engineering,* vol. 11, no. 6, June, 1940, pp. 258-259. Technical and industrial developments leading up to the present status of the low alloy, high yield strength, structural steels have had a far reaching effect in the steel castings industry. These new steels, and the demand for light weight structures, have introduced many problems involving designing and casting technique. They have proved to be difficult, but some of the difficulties are being overcome successfully by better supervision of melting, pouring, molding and sand technique. A typical example of the type of casting that is expected for landing gear assemblies is outlined in this article. The testing and x-raying landing gears must go through before being put into active use are quite interesting and tend to show the rigid specifications that are set for this type of steel casting. Concluding the article is a list of authors who have investigated the factors which lead to low ductility and shows, in a brief resume of their papers, just what they have discovered. (S.)

Cores

TESTING. *"Eliminating Variables in Core Testing,"* by H. S. Austin and C. E. Schubert, *The Foundry,* vol. 68, no. 6, June, 1940, pp. 42-43, 122-123. The authors, recognizing that a number of variables are encountered in testing core oils, have made an attempt to eliminate a number of these with a twofold view in mind. They wish to set up, if possible, (1) a standard for testing core oils for use in the foundries; and, (2) they wish to make it possible for all core oil manufacturers to submit core oils on a competitive basis which would do the work expected and demanded of them in the foundry. In order for the authors to discuss the problem they are to attack intelligently, a specific example was used and the variables examined and studied as they were encountered during a test of a core binder. (Co.)

Copper

MELTING AND CASTING. *"Melting and Casting of Copper,"* by C. R. Hayward, Masanabu Isawa, and E. M. Thomas, *Metal Industry* (London), vol. 46, no. 19, May 10, 1940, pp. 416-420. This paper gives a detailed account of the effect of atmosphere during the melting and casting of copper, and suggestions are made for the control of the soundness of low-oxygen copper in commercial practice. The tests in the experiment showed clearly that: (1) cathode copper melted quietly under charcoal in the absence of combustion gases or other gases, except those derived from the hot charcoal, may be cast in an atmosphere of nitrogen, hydrogen, carbon dioxide, or normal illuminating gas to give a billet of high density and low carbon content, and (2) cathode copper when melted, as told in (1) but cast in air, will give a billet of relatively low density, having an appreciable oxygen content. The porosity and swelled head, resulting from casting in air, are obviously due to the uniting of some unidentified combustible gas in the copper with atmospheric gas. Porosity was caused by a small amount of dissolved carbon monoxide on oxidation to carbon dioxide, this is the belief of the authors. Billets cast showed deep pipes when air was absent. In normal practice these pipes would be controlled by the rate of casting. (Al.)

MELTING AND CASTING. *"Melting and Casting of Copper,"* by C. R. Hayward, Masanabu Isawa, and E. M. Thomas, *The Metal Industry* (London), vol. 46, no. 20, May 17, 1940, pp. 439-443. This is the second section to the authors' paper dealing with a study of the effect of atmosphere on the melting and casting of copper. The authors, in this section, give the results of tests carried out with different atmospheres during melting, the atmosphere employed during casting being, in general, hydrogen. (Al.)

OXYGEN-FREE. *"Oxygen-Free Coppers,"* by S. Rolle and H. M. Schleicher, *Metal Industry* (London), vol. 46, no. 22, May 31, 1940, pp. 483-484. This is the second part of an article in which are given interesting comparative figures for the annealing and drawing characteristics of phosphorus deoxidized copper, oxygen-free high-conductivity copper and the latter metal with additions of phosphorus. Here the effect of cold drawing is considered and a comparison of the authors' results is made with those obtained by other investigators on this subject. (Al.)

Cupola

FRONT SLAGGING. *"The Advantages of Front Slagging for Any Cupola,"* by M. J. Lefler, *Pig Iron Rough Notes,* no. 80, Spring, 1940, pp. 23-25. The practice of taking the slag out of a cupola through a single tap hole, along with the molten metal, and separating this slag from the iron by skimming over the side of the metal spout, is old, but used by many foundrymen. Most foundrymen do not use the front slagging method, either because they do not understand how to use it, or because they are unfamiliar with the advantages of the method. Listed in the article are the differences between a front slagging cupola spout and the usual spout, giving information on location and construction of various parts of the spout. The operation and advantages of a front slagging cupola spout are also related. (F.)

Electric Motor Casting

MOLDING. *"Electric Motor Castings in Green Sand,"* by John Hird, *Foundry Trade Journal,* vol. 62, no. 1240, May 23, 1940, pp. 379-381. This paper is a description of the making in green sand a 4 ft. 6 in. diameter electric motor casing or shell weighing 22 cwts. and the end covers for the same motor. A definite decision had to be made upon the molding method in order to meet conditions in the foundry. It was decided to keep the molding boxes as light as possible by using a minimum amount of sand so that the 3-ton capacity crane could handle the work. If the green sand method was used and the making of a permanent pattern suitable for green-sand molding was made, the remaining shop conditions that had to be overcome would be conquered. Measurements and designs for molding boxes, core boxes, a shell pattern and core grid are given. The running arrangements for this type of casting are also shown. (C.)

Historical

CASTINGS. *"Prehistoric Metals,"* by H. D. Hibbard, *Metals and Alloys,* vol. 11, no. 6, June, 1940, pp. 168-172. This article covers a stage when metal production was in its first stages of development and getting its birth through the ability of early man to turn ore into a definite metallic form. This interesting article of the early beginnings of the production of metals, the reduction of some ores and the preparation of articles of gold, copper, tin, bronze and so on, is based on a careful study of this subject and through visits to the British and other museums by this author. (C.)

Magnesium Alloys

SURVEY. *"Magnesium and Its Alloys,"* by F. A. Fox, *Metal Industry* (London), vol. 46, no. 24, June 14, 1940, pp. 513-516. This is the first in a series of four articles dealing with a general survey of magnesium and its alloys. This is a comprehensive study of the whole field involving this element. This installment considers the production and properties of magnesium and the effect of aluminum as an alloying constituent. (Al.)

Non-Ferrous

ALLOY. *"A General Utility Casting Alloy,"* by A. Dunlop, *Metal Industry* (London), vol. 46, no. 22, May 31, 1940, pp. 473-476. An excellent account is given in this paper of the foundry practice adopted for an 88/5/5/2 nickel bronze, together with details of the heat-treatment and properties obtainable in the as-cast and heat-treated conditions; evidence is also given as to the pressure tightness of the castings produced. (N.F.)

ALLOY. *"A General Utility Casting Alloy,"* by A. Dunlop, *Metal Industry* (London), vol. 46, no. 23, June 7, 1940, pp. 497-499. Concluding his article on the five per cent nickel bronze, the author first deals with the effect of mass on response to heat-treatment and then describes the modifications which have been developed for the heat-treatment operation. Data is given which show that sections up to 4 in. in thickness can be treated quite successfully. Finally, bearing characteristics and corrosion-resistance are discussed. (N.F.)

Sand

DEFORMATION AND FLOWABILITY. *"Deformation and Flowability Tests of Molding Sands,"* by R. Chadwick, ***Foundry Trade Journal,*** vol. 62, no. 1242, June 6, 1940, p. 416. The testing of foundry molding sands and molding materials has become recognized as being a fundamental operation in the producing of sound castings, and to minimize the cost of production and foundry losses. A definite relation between the flowability and deformation of molding sand is expressed by the author. These properties are most easily controlled by varying the clay content or the moisture content, but the means adopted must depend on other properties required of the sand. The flowability test was found most useful in the control of hardness. In order to obtain the fullest information, the deformation should be recorded at intervals as the increased load is applied to the test-piece, and the results that are taken from the tests should be plotted by means of a graph. (Sa.)

SYNTHETIC. *"Synthetic Molding Sand for Gray Iron,"* by M. L. Carl, ***Pig Iron Rough Notes,*** no. 80, Spring, 1940, pp. 27-30. Synthetic molding sand requires close control; in fact, a closer control than when using a naturally bonded sand. However, it has been agreed upon that a synthetic sand is more easily controlled than natural sand, when in the same type of work. One explanation of this is that to successfully use a synthetic sand, equipment for determining the qualities of the sand are essential and are used. A procedure is then given for producing a synthetic sand by the selection of proper grain size, base sand, the study of grain distribution, etc. The article closes by outlining the various advantages of synthetic molding sand. (Sa.)

Steel

CARBURIZATION. *"Case Carburization of Steel,"* by E. G. Mahin, ***The Iron Age,*** vol. 145, no. 23, June 6, 1940, pp. 53-57. The author in his article covers the entire field of case carburization of steel, dealing with theory and practical operation in easily understood language. The first section of this paper covered pack carburizing, and dealt with data on the reactions involved, sources of carbon, role of energizers and other points of interest. The conclusion of his paper, in this section of the paper, the pearlite band in a pack carburized case is considered, as is the heat treatment of such cases. Liquid and gas carburization and selective carburization are also discussed. (S.)

CHROMIUM. *"How to Cut Chromium Steel Castings,"* ***Canada's Foundry Journal,*** vol. 13, no. 6, June, 1940, pp. 5-8. Removal of risers from chromium castings of oxidation-resistant steel is shown to require special blowpipe technique. In determining what cutting technique to use in cutting chromium steel castings, it is highly important to know the analysis of the steel. In general, it may be said that the ease of cutting the steels decreases as the chromium content increases. Procedure for the cutting of castings with certain percentages of carbon, castings of the straight chromium steel variety and low chromium steel variety are discussed. Due to the air-hardening properties of the straight 4 to 6 per cent chromium steels, rapid cooling of local areas heated during the removal of risers either by grinding or by oxy-acetylene must be guarded against. If the metal is not ductile the hard material, produced by the cutting action of the oxy-acetylene on the cut surfaces, will crack because of high stresses set up during cooling and use. Prevention for this defect is to preheat the entire casting to about 900° F. before starting the cutting operation. Various methods of preheating are given but preheating depends upon the annealing practice of the individual foundry. Steel containing more than 10 per cent of chromium requires different cutting procedure from that used for those alloys which contain less chromium, because a greater percentage of chromium oxide slag—which fuses with difficulty—is formed. The apparatus that is to be used, the cutting procedure to be followed, and blowpipe manipulation are set forth for the cutting of a steel containing 10 per cent or more chromium. The paper closes giving data on the economy of the operation, through the use of experienced cutters, and the significance of tolerances as a matter of judgment. (S.)

INCLUSIONS. *"Formation of Inclusions in Steel Castings,"* by Walter Crafts, John J. Egan and W. D. Forgeng, ***Metals Technology,*** vol. 7, no. 3, April, 1940, T. P. no. 1184, 18 pp. In this paper the authors, by means of phase diagrams, have endeavored to outline the mechanism for the solidification and formation of various types of inclusions in steel for castings where various types of deoxidizers have been used. This work was undertaken primarily as a study of the effect of various types of inclusions and the relation of different types of deoxidizers on the ductility of the steel. The solidification diagrams, as emphasized by the authors, are the result of metallographic observations and, therefore, are qualitative rather than quantitative, but the authors hope, nevertheless, that they will be a guide to the relation of inclusions to the ductility problem. The solidification diagrams have been constructed on the basis of the following assumptions: (1) Random oxides (silicate or alumina) are formed at a liquid miscibility gap. (2) Round sulphides and oxide particles distributed in a rough network formation are formed as binary eutectics between metal and sulphide, and metal and oxide, respectively. In higher aluminum steels, translucent round sulphides are formed as a binary eutectic between metal and a oxysulphide compound. (3) Intergranular fine sulphides represent a ternary eutectic between metal, sulphide and oxide or oxysulphide compound. (4) Galaxies, or clusters of oxide particles, similarly represent a ternary eutectic between metal, oxide, and oxysulphide compound. (5) Duplex inclusions having a geometrically shaped oxide core and sulphidelike periphery are formed by an incompleted peritectic transformation from oxide to oxysulphide compound. Solidification diagrams were drawn for the following types of inclusions: silicate, eutectic, galaxy, alumina and peritectic.

According to the authors, steels of medium-carbon content deoxidized with 0.25 to 0.50 per cent silicon contain inclusions of the silicate type when treated with a strong deoxidizer or with not more than 0.025 per cent aluminum, titanium or zirconium or up to 0.10 per cent calcium . While the tendency apparently is to form a network, this network is often poorly defined and is not sufficient to impair the ductility of the steel. If an addition of aluminum, titanium or zirconium is made to a steel of the silicate type in sufficient quantity to change the character of the inclusions, the initial result is a decrease in the amount of silicate inclusions with corresponding increase in the fine intergranular sulphides and loss of ductility. In such cases, the type of inclusion generally formed is eutectic. The amount of aluminum required to produce this condition is about 0.05 per cent in the medium-carbon steel that was produced by the authors in their laboratories.

When aluminum to the extent of 0.075 per cent is added as a deoxidizer to steels of the type mentioned above, the alumina particles tend to form in clusters or galaxies numbering from a few to thousands. In order to explain the reason for the formation of the inclusions of the galaxy type it has been necessary for the authors to assume the formation of an oxysulphide compound, the existence of which has not as yet been definitely determined. The oxide galaxy inclusions do not appear to be quite as harmful to ductility in the tensile test as the intergranular sulphides and the latter is said to be more prone to allow hot tearing than when the inclusions appear in the oxide galaxy formation.

The addition of 0.10 per cent aluminum to steels of the type discussed in this paper appreciably restores ductility. Under ideal conditions, the inclusions consist of randomly distributed alumina and round sulphides (oxysulphides) in a network formation. According to the authors, there exists a critical sulphide to oxide ratio which will produce optimum ductility after a steel of the type under discussion has been deoxidized with 0.10 to 0.20 per cent aluminum. This optimum composition is probably the highest ratio of sulphide to oxide that will permit the maximum amount of inclusions to be formed as binary eutectic between metal and oxysulphide with the assurance that the last material to solidify will be rich in oxide rather than in sulphide. The authors believe that the critical amount of sulphur in the case of deoxidation with 0.10 to 0.20 per cent aluminum is about 0.040 per cent sulphur. Inclusions formed by deoxidation with 0.10 to 0.15 per cent titanium indicate that the critical sulphide to oxide ratio is nearly the same as that found with aluminum and that for those deoxidized with zirconium the ratio appears to be slightly in excess of 0.050 per cent sulphur.

In steels which receive an addition of 0.10 to 0.20 per cent aluminum, titanium or zirconium, calcium-bearing alloys often are added. Under such conditions, a peritectic type inclusion is formed with an addition of 0.05 to 0.10 per cent calcium. The use of calcium seems to make the sulphur content of the steel less critical and provides a buffer against irregularities in distribution of the deoxidizer that might lead to the formation of galaxies in zones of relatively low deoxidizer content. Steels of the peritectic type seem to have the same degree of resistance to hot tearing that has been found in the strongly deoxidized steels that are not treated with calcium. (S.)

TEST-PIECES. *"Design of Test-Pieces for Carbon Steel Castings,"* by C. H. Kain and E. W. Dowson, ***Foundry Trade Journal,*** vol. 62, no. 1243, June 13, 1940, pp. 435-436. The freezing phenomena of test-blocks designed for the provision of test-pieces for steel castings have been considered. Rules governing the design of an ideal test-block are suggested and a section resembling a clover-leaf recommended. Data are given in support of this recommendation. (S).

FUNDAMENTAL FOUNDRY INFORMATION

A Partial List of Available A. F. A. Publications

BOUND VOLUMES OF TRANSACTIONS

Containing a wealth of material in papers and committee reports as presented before annual conventions. At present only 4 of these are available. The supplies are limited, but those which are available are for those most recent conventions when papers and reports have been most numerous and on problems and practices of current importance. These volumes are the foundation of any library of foundry reference books.

Publication No.	Years	No. Pages	Price to Members	Price to Non-Members
V47	1939	1030	$3.00	$15.00
V46	1938	950	3.00	15.00
V45	1937	850	3.00	10.00
V41	1933	608	2.00	6.00

Publication No. 21

Latest Safety Code—Just Off the Press

Code of Recommended Good Safety Practices for the Protection of Workers in Foundries.

(1940) 69 pp. Planograph. 8½x11. Heavy paper binding. Price $2.50. To members $1.25.

This code of Recommended Good Safety Practices for the Protection of Workers in Foundries has been developed to cover the necessary engineering and good housekeeping requirements, as well as specifications for personal protection, wherever such operation may be carried on in the gray iron, malleable, steel and nonferrous branches of the foundry industry. This code also covers prime movers, the pattern, machine and maintenance departments, which are considered as part of the foundry in their operation. This is the fifth in the series of Recommended Good Safety Practice codes developed by the A.F.A. Industrial Hygiene Codes Committee and approved by the Board of Directors as Recommended Practices for the Foundry Industry.

Publication No. 40-13

Application of Controlled Directional Solidification to Large Steel Castings, by J. A. Duma and S. W. Brinson.

54 pp., 6x9 preprint (1940). Price $1.00. To members $0.50.

The successful foundry technique used by the Norfolk Navy Yard for large and intricately shaped castings involves six major factors. These are discussed individually and in detail by the author. Actual cases are presented which help illustrate the various ways in which the direction of solidification is being controlled successfully on large work. Published by permission of the Navy Department.

Publication No. 50

The Microscope in Elementary Cast Iron Metallurgy, by R. M. Allen.

143 pp. 6x9 preprint, 73 illustrations, (1939). Cloth binding. Price $3.00. To members $1.50.

A book containing material of lectures presented by the author before 1939 A.F.A. Convention. Designed to meet the needs of the shop man and student in understanding the microstructure of cast iron. Discusses the fundamentals of physical cast iron metallurgy, showing extensive illustrations of various types of structures. Outlines effect of forms of graphite, silicon, sulphur, manganese and phosphorus. A chapter is devoted to special cast irons such as white, chilled, malleable, alloy, special duty and heat treated. The chapter on the cast iron equilibrium diagram is easily understood. A major section is a detailed explanation of the microscope and technique of its use, together with the preparations of samples.

Publication No. 39-11

Symposium on Steel Melting Practice.

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A compilation of six papers presented before the 1939 Convention, covering melting practices in the acid and basic open-hearth, acid and basic electric furnaces, the induction furnace and the converter shops. The basic open-hearth practice is treated by J. W. Porter, American Steel Foundries, the acid open-hearth by W. C. Harris, Birdsboro Steel Foundry & Machine Co., the basic electric furnace by C. W. Briggs, Steel Founders' Society of America, the acid electric furnace by W. Finster, Reading Steel Castings Div., American Chain & Cable Co., the induction furnace practice by G. F. Landgraf, Lebanon Steel Foundry, and converter practice by F. B. Skeates, Link-Belt Co. This is the first comprehensive survey of Steel Melting Practices in many years and gives much valuable information to anyone interested in this subject.

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